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1.—The Potential of Some Native West Australian Plants as Pasture Species

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It is in the tradition of this Society that first consideration should be given to the things which are ours. The rocks which underlie us, the soils which develop on those rocks, the plants which grow on those soils and the animals which eat those plants have been the subject of previous Presidential addresses to this Society. The most recent of the addresses on geology was that of the immediate past-President, Dr. Wilson. Professor Teakle in 1938 made the first detailed attempt to regionalise West Australian soils and in 1942 Mr. Gardner's address related the native vegetation to the soils and climate of the State. More recently Professor Grieve (1956) has discussed the physiology of the native plants, particularly in respect to drought resistance and Dr. White (1958) has reviewed them as sources of drugs of economic importance. It is their potential as forage plants that it is proposed to examine tonight.

On maps showing the Centres of Origin of Cultivated Plants, Australia is a conspicuous blank. This is partly due to biological chance, but also, and quite importantly, probably, to the fact that the Australian native never interested himself in agriculture. The great civilisations of the world followed the domestication of wild species. The Mayas in Mexico used maize, the Incas of South America depended on the potato, while the civilisations of Asia including our own and those of China and India were built upon the use of cereals, principally wheat and rice. By contrast, no very serious attempt was made to use any indigenous Australian plant for human food, although a number are probably not inferior in productivity and nutritive value to the wild ancestors of many species cultivated elsewhere. In the words of Charles Darwin "primitive man ate anything which he could chew and swallow" and the Australian native never rose above fern-like nardoo.

The agriculture and much of the pastoral industry of Australia is dependent, therefore, on the use of introduced plants, developed by older civilisations, with no serious attempt to domesticate, or even to preserve, the indigenous flora. Many species have become either totally or very nearly extinct, and, unfortunately, the palatable ones, with the greatest agricultural potential, are those most likely to be exterminated by rabbits and man's grazing animals.

The position of Australian plants in relation to extinction is not unique for it is likely that many of the common forage plants have survived only because recurrent wars and pestilence depopulated at fairly frequent intervals, the countries in which they originated. This gave the plants opportunities to adapt themselves to man and his grazing animals.

By contrast Australian plants have had no such opportunities. Sheep numbers were high sixty years ago while the modern plough and the tractor have subjected plants to more frequent and thorough cultivations than were possible in earlier civilisations. The lesson of evolutionary biology is that failure to compete and adapt to changing climatic and other conditions results in extinction, but practically nowhere in the world do we find plants which have the innate capacity for adaptation to the cataclysmic changes which come with modern land development. By the same token, never before have so many tools been available to achieve, in the words of the Russian scientist Vavilov, "evolution by the will of man".

Sheep numbers in Australia

1890	—	97 million
1940	—	125 ,,
1946	—	95 ,,
1957	—	150 ,,

The rich and unique flora of Australia appears to be destined for extinction either by overgrazing or by competition from introduced plants, an eventuality which most Australians appear to contemplate with complete equanimity.

Occasionally our attention is directed to the fame which our Eucalypts have achieved overseas, or, as in South Africa, a tannin bark industry has been developed on the basis of an Australian plant, the wattle.

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Following its accidental introduction as an impurity in commercial Rhodes grass seed an Australian grass, *Dicanthium sericeum* syn. *Andropogon sericeus* has become dominant in parts of Texas and local ranchers are now gathering seed for extensive plantings. This particular grass has been "eaten out" over extensive areas in its native habitat in Queensland, but research work is now being undertaken at the Gatton Agricultural College with a view to selecting superior strains and three have been distributed for regional testing.

In the agricultural areas development was dependent on introduced cereals and with the increasing importance of pastures, it has been the most practicable procedure to seek grazing plants from the same source. While these plants have evolved in areas of similar climate, they have developed, for the most part, on soils, which, for geological reasons, are of much higher inherent fertility than those used for agriculture in this continent. In Western Australia, the lateritic soils, which cover three quarters of the agricultural areas already developed and characterise the ten or fifteen million acres remaining, are extremely poorly supplied with plant nutrients. Before introduced plants can be grown on these soils, massive and expensive applications of superphosphate and trace elements are required and there is evidence that on deep sands, potash fertiliser will be required. Within a very short space of time, decisions in respect to considerable areas will need to be taken as to whether they are to be worked at a high, or a low plane, of plant nutrients. Whether it will be more profitable to spend heavily on fertilisers and farm at a high level of productivity, or economise and carry many fewer sheep, can only be determined on the basis of experimental data, but there can be little doubt that the cost of fertilisers will be of paramount importance on the millions of acres of sandplain soil at present in use, or about to be used, in the more favoured rainfall areas of this State.

By contrast to the introduced legumes, the native plants grow and thrive with little or none of the expensive diet of nutrients applied as fertilisers. For a State, such as Western Australia, which has an annual fertiliser cost of at least £10,000,000 this is of importance. To approach the climatic potential of the State, an annual outlay on fertilisers of twenty to thirty million pounds will be required each year.

Any decision to develop species for economic purposes should be made on the basis of such data as are available from practical experience and scientific research.

The pastoral industry depends on native plants but overgrazing by sheep and rabbits, has greatly reduced the carrying capacity of these regions. This has lead to the belief, that native species will not withstand grazing, but investigations by the Department of Agriculture in the north of this State have clearly demonstrated that given relatively simple management, in the form of deferred grazing, the native plants of these areas can be made as productive as ever (Nunn and Suijdendorp 1954). Where over-grazing has proceeded to the point of extermination, such as around watering places, there is the opportunity to introduce superior strains of local species.

Assuming that it appears to be worthwhile to consider the problems likely to be encountered in domestication they can be summarised as (i) collection, classification, crossbreeding and selection, (ii) small scale trials to make a first assessment of the agronomic potential of the various strains and species, (iii) seed increase with its associated problem of seed gathering and (iv) controlled large scale trials under practical conditions with the most promising types. A reasonable approach could be made at a level of annual expenditure of £30,000-£50,000 per annum over a period of 10-20 years, or a total, at its highest level of annual expenditure and maximum duration of less than 10% of one year's fertiliser bill.

All agricultural countries are interested in legumes, not only as pioneer species on new and worn out land, but also for their high protein content. Of the native legumes, the *Swainsona* species are at present, probably the most important. An investigation of their economic potential was made by A. W. Humphries as part of a programme of research commenced at the University of Western Australia, Institute of Agriculture, under Professor E. J. Underwood's direction in 1950. This programme resulted from the belief that native legume species and particularly those from the wheatbelt and pastoral areas had, in view of their adaption to the climate, a potential as economic plants. Some of the 52 species of *Swainsona*, native to Australia, are toxic but *S. occidentalis*, known as "purple vetch", is an important fodder species in the Murchison region and *S. canescens* in the north-east Goldfields area of this State. (Fig. 1).

The second genus of legumes investigated in this programme, the *Kennedya* is confined, except for one species *Kennedya prorepens* to the agricultural and dairying areas of the State. All are perennials of high palatability to livestock and are prominent in a disturbed habitat such as that following clearing and burning. They usually do not persist under the subsequent grazing and a factor contributing to this is the 80% or so of hard seeds which do not germinate for some years, so that there is no immediate regeneration despite heavy seeding (Silsbury 1956).

Replicated sward trials were planted at Meckering in 1952 to compare the productivity of seven *Kennedya* ecotypes relative to lucerne, sub-clover, peas and vetches. All the perennials were cut back in May, 1953 and the plots sampled in November, 1953 and again in November, 1954

TABLE I

Meckering Yield Trial

Species	Yield cwts./acre (dry weight)		
	May, 1953	Nov. 1953	Nov. 1954
K. prostrata (Northam)	15·0	22·5	20·0
K. stirlingii	3·7	11·4	16·2
Lucerne	0·6	2·0	0·6
Dwalganup sub-clover	....	11·5	....

for yields which showed that some of the native plants tested were comparable and even superior to the introduced ones in productivity (Silsbury 1958). Yield data for the two most productive *Kennedya* types, relative to lucerne and sub-clover, are given in Table I.

Fig. 1.—*Swainsona oroboides* growing at Cook on the Nullabor Plains where the average annual rainfall is six inches.

Trials were conducted also, at Merredin Research Station to obtain data on the effect of various times of cutting on the Northam strain of *K. prostrata*. Comparative trials with introduced legumes on the lighter soil types at Merredin proved abortive because these failed to nodulate and regenerate.

TABLE II

Merredin Research Station 1953-54
K. prostrata planted May, 1952

Time of cutting	Yield cwt./acre (dry matter)
3rd June, 1953	6·8
3rd September, 1953	9·7
3rd November, 1953	(16·3 plus 1·6 seed) 17·9
3rd March, 1954	5·9

The lower yield of the March cut was due to the loss of foliage following seeding. This trial was on a relatively small scale and border effects became apparent due to the depletion of the subsoil moisture to the maximum depth of sampling, 42 inches. The seeding re-establishment was relatively poor but despite the dry seasons the *Kennedya* appears to have become stabilised and in 1958 there was a considerable germination of seedlings in mid-June.

As Silsbury has pointed out, *Kennedya* is one of the few perennial legumes which are adapted to survive in a Mediterranean climate and in view of his demonstration of its capacity to produce commercial yields, the development of suitable methods of management may well be justified. (See Fig. 2).

While some *Kennedya* species may have a place in the general agriculture of this State, native species have already demonstrated their value in reclaiming salt affected soils. It has been calculated that 5% of the agricultural areas of the State are affected by salt and although this is a small percentage of the total, it amounts to a million or so acres. The problem has various manifestations, but the continued utilisation of these soils is dependent on the use of salt-tolerant plant species.

Research by the Department of Agriculture showed that for seepage areas a grass, *Paspalum vaginatum* obtained by the Waite Institute from South Africa, was very satisfactory, but as it set no seed, it could be established only from cuttings. This method of establishment is not easily achieved over large areas and investigations were made at the University Institute of Agriculture by Carpenter (1958) with a view to developing a free seeding type. He found that *P. vaginatum* was native also to the Queensland coast and that this type did set a little seed under Perth conditions.

Fig. 2.—*Kennedya prostrata* (Crawley ecotype) has a depth of root penetration of over six feet compared with 15-18 inches for sub-clover (right in above photo). This enables it to bring moisture and nutrients from a considerable depth.

Material forwarded from Cheyne Beach near Albany by Col. Bleechmore was also self-sterile, but by crossing the different types, relatively good seed setting was obtained. It may well be that the grasses collected from Albany are native to the region.

Fig. 3.—*Kochia brevifolia* being used to reclaim salt affected land in the West Australian wheatbelt.

Investigations of a number of ecotypes of another native salt tolerant grass, *Sporobolus virginicus* have been made at the Institute of Agriculture by Frith (1957) and these have shown that they are variable according to source of collection, but free seeding. The problem of establishing grasses on salt affected seepage areas from seed is therefore now largely a matter of commercial seed production.

Fig. 4.—The inherent variability in wild species is of great importance in a breeding and selection programme. One plant of Old Man Saltbush (*A. nummilaria*) made exceptional growth relative to others of the same species in the collection at Merredin Research Station.

TABLE III

Paspalum vaginatum

Type	Fertile Flowers
	Per cent.
South African selfed	0
,, ,, x Cheyne Beach	32
,, ,, x Queensland	13
Queensland selfed	11
,, x Cheyne Beach	50
,, x South African	44
Cheyne Beach selfed	0
,, ,, x South African	32
,, ,, x Queensland	45

The salt and blue bushes, *Atriplex* and *Kochia* respectively, are important genera in the pastoral areas of Australia. Working with funds provided by a New South Wales foundation, the George Aitken Pastoral Research Trust, A. W. Humphries, while a Research Officer of the Institute of Agriculture, asembled a collection of these and related genera. This collection showed that within each species there is a range of variability which could well be the basis for the development of superior strains for use in re-seeding "eaten out" areas.

Fig. 5.—*Glycine tabacina*, a native perennial legume, growing on the roadside near Bruce Rock in Western Australia. This plant has the capacity, which may have agricultural value, to regenerate from roots cut well below the surface and exposed to sunlight.

More recently the Department of Agriculture and Mr. B. Parker of Kulin have demonstrated the value of *Kochia brevifolia* for the reclamation of salt land. Not only does this perennial colonise the eroded areas, but it provides a reserve of very nutritious green fodder for use in periods of summer drought, so that there is a marked improvement in both the quantity and the quality of feed available on otherwise unproductive land (Fig. 3).

Kochia brevifolia is widely distributed over southern Australia and is not confined to salt-affected soils. Experimental work dating from 1937 at Merredin Research Station on the local ecotype included a series of feeding stuffs analyses from material harvested during the period from August, 1941, to March, 1942. These investigations by the Department of Agriculture showed that the crude proteins ranged from 22% in October to 32% in March with figures as high as 35% for new growth. The vitamin A content during the early summer has been shown (Underwood and Conochie 1943) to be 12 mg/100 gr. on a dry basis compared with less than 2mg/100 gr. for the mature annuals in the pasture. Blue bush is very low in fibre and therefore should balance the normal dry feed, but D. H. Curnow has directed attention to its oxalate content of 6% on a dry weight basis. From these data it appears that *K. brevifolia* may well have a place on every wheat farm as a source of high protein and vitamin rich supplementary fodder, during the long dry summers and the Department of Agriculture is undertaking a seed increase programme to make it more freely available to interested farmers (S. T. Smith, personal communication).

While the native flora is already making a contribution and has a considerable potential, the problems associated with its domestication are considerable.

It is for this reason that the Royal Society has advocated the establishment of a Botanic Garden. To many such a Garden should not be a graveyard where the last sad vestiges of a once great flora would be preserved from total extinction. Rather, it should serve as a centre from which a vigorous programme of research and development, as well as preservation, could be inspired and co-ordinated. The legislation governing the conservation and utilisation of our flora is for the most part dated 1895, at least in concept, if not in enactment and a review of the position in the light of modern developments is long overdue.

It is visualised that a function of the Garden would be to provide funds, to enable the various organisations to conduct specific research projects, as part of continuing programmes of domestication and conservation.

The collection and maintenance of as many species as possible is an extremely urgent one, for delay will reduce the chances of ultimate success in plant domestication by restricting the range of material available. Already the list of native plants which are believed to be extinct is formidable and the heath flora is still disappearing at the rate of hundreds of thousands of acres per year. There is evidence that any uncultivated areas on farms will not persist, for sheep need roughage to balance a predominantly sub-clover diet. When Silsbury began his collection of species of *Kennedya* he was unable to locate one species and he had great difficulty in finding others which were, from botanical accounts, common and widespread during the earlier days of settlement. Within a few years great sections of our flora outside the forest reserves will be extinct and among them will be many with the greatest potential for economic development.

The need for a range of plants of any species is shown in the development of a disease resistant strain of the red-flowering gum, *Eucalyptus ficifolia* (Cass-Smith, personal communication). Only one tree in about four hundred carries the heredity for immunity to the fungal wound parasite which causes the die-back in trees of this species. It would be easy, therefore, to test one thousand trees without obtaining the desired immune one.

In addition to the urgent and immediate need for plant collection and preservation, research will be required into the problems of management, germination and nutrition. At the University Institute of Agriculture programmes of investigation on seed germination have been undertaken with some *Kennedya* species, *Atriplex* and *Kochia* genera. Most species have evolved controls which, while they make them well adapted to survive under natural conditions, create difficulties in respect to their use in agriculture, for the conditions under which seed will germinate obviously affects establishment.

With *Kennedya* Silsbury demonstrated that by scarification alone, germination could be increased from 15% to 62% which would be satisfactory for establishment. Firing gave no improvement in germination. Salt tolerant species are apt to germinate slowly and poorly. With the salt tolerant grass, *Sporobolus virginicus*, Frith found at the Institute of Agriculture, that germination was aided by both light and the fertiliser, potassium nitrate. He suggested that by planting the seed in narrow furrows with potassium nitrate, good germination and establishment should be obtained.

Establishment difficulties due to poor germination are usual with salt and blue bushes. Investigations by D. G. Wilcox at the University Institute of Agriculture have shown that seed disinfection with a fungicide such as organic mercury and planting in late autumn can markedly improve germination.

These studies apart from their direct value, have served to show that many of the serious barriers to the domestication of our native plants can be overcome by research.

The reliance on introduced winter growing annuals has resulted in the development of systems of grazing management to which the native perennials are not well adapted, for the scarcity of green feed during the summer can result in their being exposed to extremely high stocking rates. Every green supplement, high in protein and vitamin A is particularly valuable. When it is appreciated that on most wheat farms, about one half of the wool is grown during the four or so months of green feed, the value of such a supplement may be to achieve more than just the maintenance of the sheep in good health. Yields obtained by Silsbury with *Kennedya*, and Mr. B. Parker with blue-bush suggest that the quantity of fodder produced would be considerable.

It is likely that for native legumes controlled grazing will be necessary during the summer months but with *K. brevifolia*, protection from stock appears to be necessary only in the year of establishment. Consequently a few acres of *Kochia* in each paddock would provide a valuable summer supplement at very small cost.

Although the general experience is that native species do not persist under grazing, this may be a result of insufficient ecotypes being tested. It has been observed by Silsbury that *Kennedya prostrata* if heavily grazed will shoot from below the crown, while a glycine from near Shackleton has been observed to regenerate from a root cut eight inches below the surface (Fig. 5). With *Swainsona beasleyana* at Mukinbudin, rabbits regularly cut the plants back to an inch or more below ground level without killing them.

At Kukerin Mr. A. R. Abbott has *Kennedya prostrata* which has persisted in a paddock that has been cropped and grazed for 40 years, while *K. prorepens* has survived 30 or so years of farming at Ghooli east of Southern Cross.

Before large scale grazing trials can be conducted, it will be necessary to obtain seed in commercial quantities. Dehiscence at maturity is a characteristic of wild species, but non-shattering types would greatly simplify seed collection. Such forms have been developed for most cultivated species and mutation induction by irradiation could be used if no suitable plants were found in nature. Plant breeders now have a wide range of chemical and other techniques for inducing variation, so that, given time, almost any plant could be tailored for domestication.

In considering the implementation of a new policy towards our native plants, the Royal Society is mindful that the National Parks Board of Western Australia is the organisation nominated by Parliament in the Act of 1895 to manage parks and reserves vested in the Crown. This Act instructs the Board to "Otherwise improve or ornament such parks or reserves and do all such things as are calculated to adapt such parks and reserves to the purposes of public recreation, health and enjoyment". While the demand for recreational areas is becoming greater each year, the need for an organisation with adequate funds and staff to ensure the preservation of our flora as well as its exploitation, is urgent and preferably its headquarters should be located, with the Herbarium, in a Botanic Garden.

It is only by having in existence such an organisation that adequate parks, both regional ones in the country and others in the city, could be created and maintained to serve the recreational as well as the economic needs of the community. The need to co-ordinate and classify research in such diverse fields as pharmacology and the physiology of salt tolerant grasses is self-evident, while there is little of tourist interest in this State once the wild flowers have disappeared. The Royal Society has prompted the Government to enquire into the possibilities of establishing such a Garden and related organisation and I feel sure that, as in the past, our leaders in public life today are statesmen who will give the proposals the careful and urgent consideration which they merit.

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